COMPARISON OF TEMPERATURES FROM ROOF AND GROUND EXPOSURES AT TOPEKA, KANS., 1935–36

By A. D. ROBB

[Weather Bureau, Topeka, Kans., April 1937]

Two temperature records, using standard Weather Bureau instruments, have been maintained at Topeka, Kans., since October 15, 1934—one on the roof of the Federal Building, where the Weather Bureau office is located, and the other at 440 The Drive, about 2½ miles almost due west of the Weather Bureau office. The thermometers at the Weather Bureau office are in a standard instrument shelter, and those at 440 The Drive are in a cooperative observer's instrument shelter. The former thermometers, designated No. 1, are 8 feet above the tar and gravel roof, and 65 feet above the ground; the latter, No. 2, are 5 feet above sod, and have a good exposure. The instrument shelter on the Federal Building is 28 feet north of a penthouse which extends 12.5 feet above the roof of the major portion of the building; the shelter is 4 feet below the level of the roof of the penthouse. Thermometers No. 1 are 60 feet higher than No. 2.

The substation 2 was established in order to determine the difference in temperature at the respective exposures and to determine what, if any, influence the penthouse has on the temperature at station 1. The results of 2 years of observations, 1935–36, are given in tables 1 and 2, and figures 1 to 7.[1]

The mean annual temperatures at the two stations are almost identical. In 1935 the mean temperature at 1 was 55.7°, and at 2 it was 56.1°, 0.4° higher; in 1936 the mean temperature was the same at both stations, 56.5°.

The mean maximum at station 2 was higher than at station 1 in all months of the 2 years; the mean minimum at the substation was as low, or lower, in every case but one, May 1935. At the substation, the extreme maxima have been the higher in all but 5 months. The substation also had the extreme low temperatures in a majority of the months; and only during the winter months did the extreme low temperatures recorded on the roof of the Federal Building equal or exceed those recorded near the ground. At the ground exposure, the temperature was especially lower in hot, dry weather.

To investigate the reasons for the differences found, the daily maxima and the daily minima at the two stations for 1935 and 1936 were compared. Most of the time the maxima at station 2 were the higher; at times as much as 6° difference occurred. When the maximum was higher at the Weather Bureau office the difference never exceeded 2°. The minimum temperatures at the ground station were usually lower than on the roof, the difference sometimes reaching 13°. When the minimum was lower at the roof exposure, the difference did not exceed 2°. See figure 1.

Four elements appear to affect the difference between the maxima at the two exposures, viz, state of weather, wind direction, wind speed, and moisture conditions of the ground. Figure 2 shows that the greater differences tend to occur during clear weather. Figure 3 shows that only southerly winds ordinarily produced higher maxima at the roof exposure than at the ground exposure; the majority of times when the maxima were higher at the roof station occurred in either clear or partly cloudy weather. Of course there is some correlation between wind direction and state of weather; but the observed effects may be due in some measure to the influence of the roof and penthouse. The prevailing wind direction is south. Figure 5 shows that wind speed has little effect.

During the drought conditions of the past two summers, two good examples of the effect of ground moisture have occurred: On June 26, 27, 28, 1935, rain fell, totaling 1.93 inches, which soaked the ground well. During the 16 days, June 26–July 11, 1935, there were only 4 times when the maximum temperature at station 2 was higher than that at station 1, and 12 times when the maximum at 1 was as high as or higher than at 2; but during the 39 days following July 11, a period of light rainfall and temperatures of 100° or over nearly every day, the temperature at station 1 exceeded that at 2 only once. The rapidity with which the roof of the Federal Building dries out, while the soil remains wet, explains the difference.

Again, on June 5, 1936, 1.07 inches of rain fell at the substation, giving the soil abundant moisture. On June 8, the first of many days with a temperature of 100° occurred at the roof station. During the 22 days from June 5 to June 25, inclusive, there were 11 times when the maximum temperature at this station was as high as or higher than at the ground exposure; but during the following 76 days, the maximum temperature at the ground exposure always equaled or exceeded that at the roof exposure. When the September rains came the relation reversed again.

The differences in the minima are also affected by the same four factors. Figure 4 shows the effect of the state of weather. Figure 5 shows a pronounced effect of wind velocity on the difference in the minima; high winds tend to produce a lower temperature at the Weather Bureau office than at the ground station; figure 6 shows the effect of wind velocity in different states of weather. The influence of wind direction is shown in figure 7. No difference between the two minima was usually associated with northerly or easterly winds. South, southwest, or west winds produced temperatures 1° or 2° lower near the ground than on the roof more often than other directions; the greatest range in the differences occurred with west winds.

Dry weather seems to cause lower minima near the ground than on the roof. During 1935 and 1936, there were 10 months with above-normal precipitation; and during those 10 months, there were 56 times when the minimum temperature at the ground was 5° or more lower than on the roof. In contrast, during the 14 months when the precipitation was below normal, there were 110 times when the minimum temperature at the ground was 5° or more lower than on the roof.

The times at which freezing temperatures occur in the fall and spring may also be compared. The record at the two stations now covers three fall seasons and two spring seasons. The first freezing weather in the fall was recorded on the same date at both stations during each year. In the spring of 1935 the last freezing temperature at the Weather Bureau office was recorded on April 15, with a minimum of 30°; and at the substation the last recorded freezing temperature was 32° on April 16, 1 day later. In 1936 the last recorded freezing temperature at the roof exposure was 24° on April 7; after that date,

[1] *Cf.* the similar studies by B. R. Laskowski, Ground temperatures compared to roof temperatures [at Topeka], MON. WEATH. REV., 64: 17, 1936; and C. A. Donnel, Temperature relations between the two Chicago, Ill., Weather Bureau stations, MON. WEATH. REV., 62: 131–132, 1934.

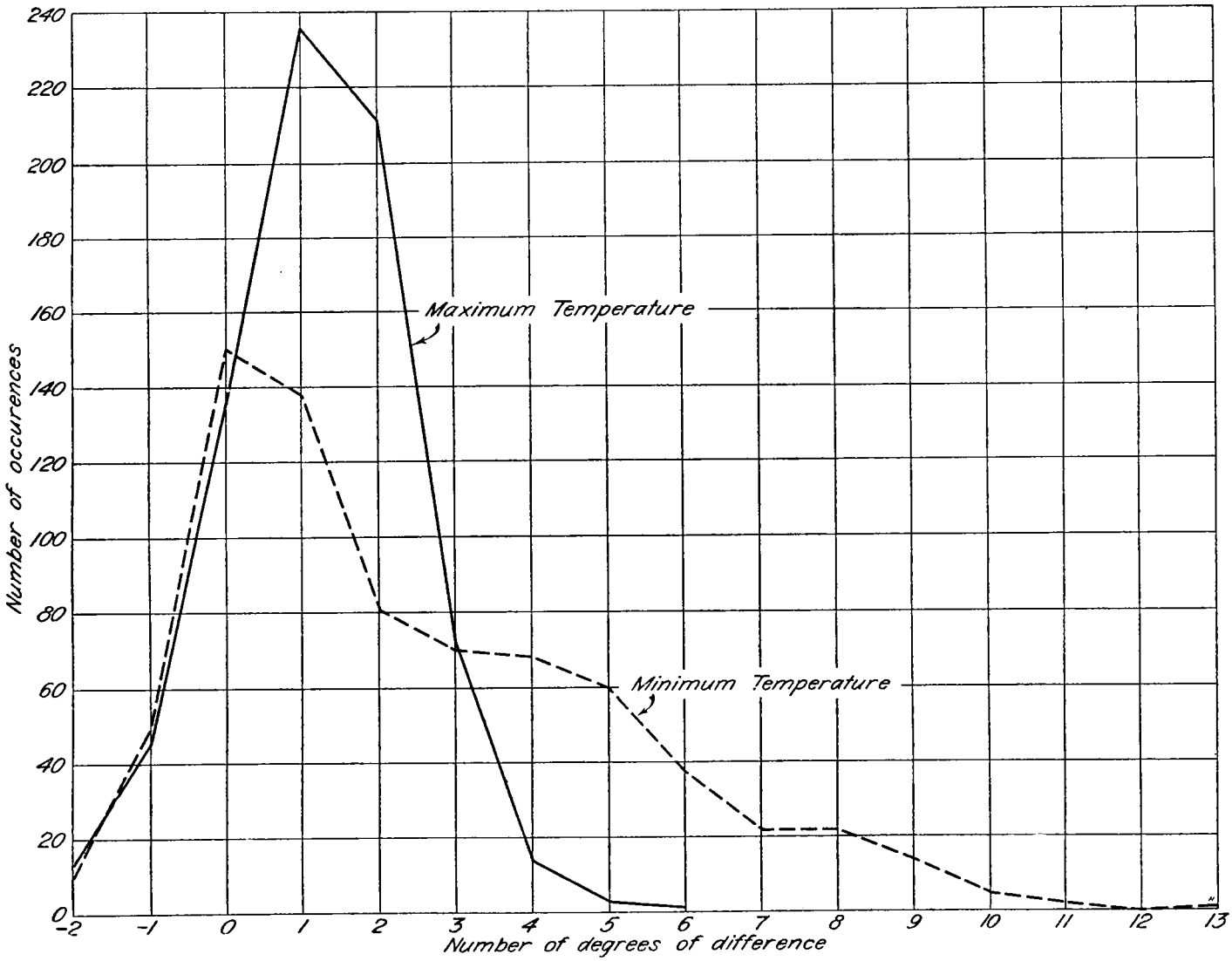

FIGURE 1.—Frequency distributions of differences in maximum temperature (ground minus roof) and minimum temperature (roof minus ground).

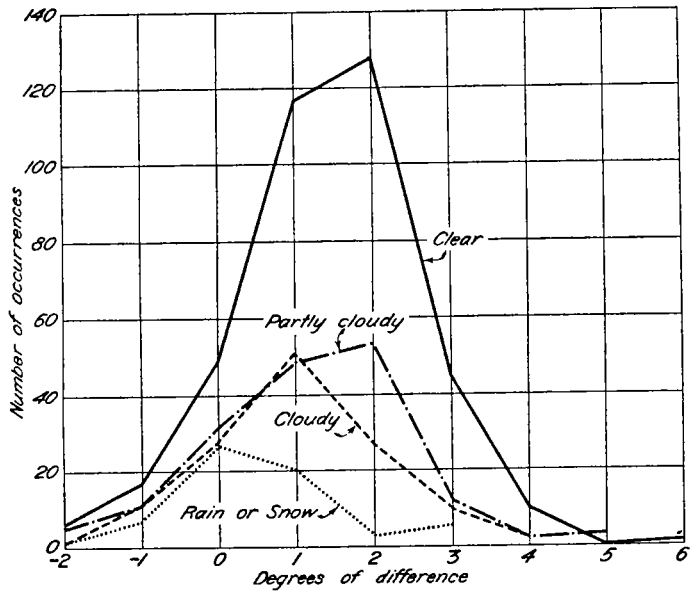

FIGURE 2.—Frequency distribution of differences in maximum temperature, ground minus roof, by states of weather.

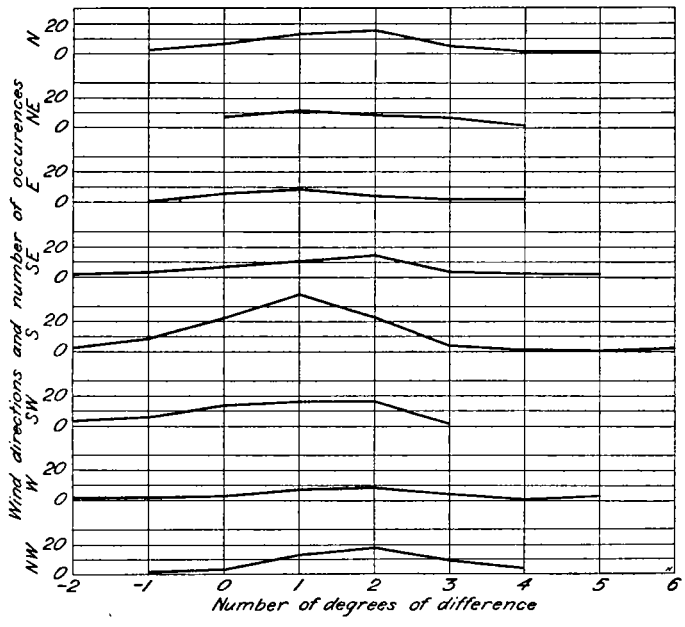

FIGURE 3.—Frequency distribution of differences in maximum temperatures, ground minus roof, by wind directions.

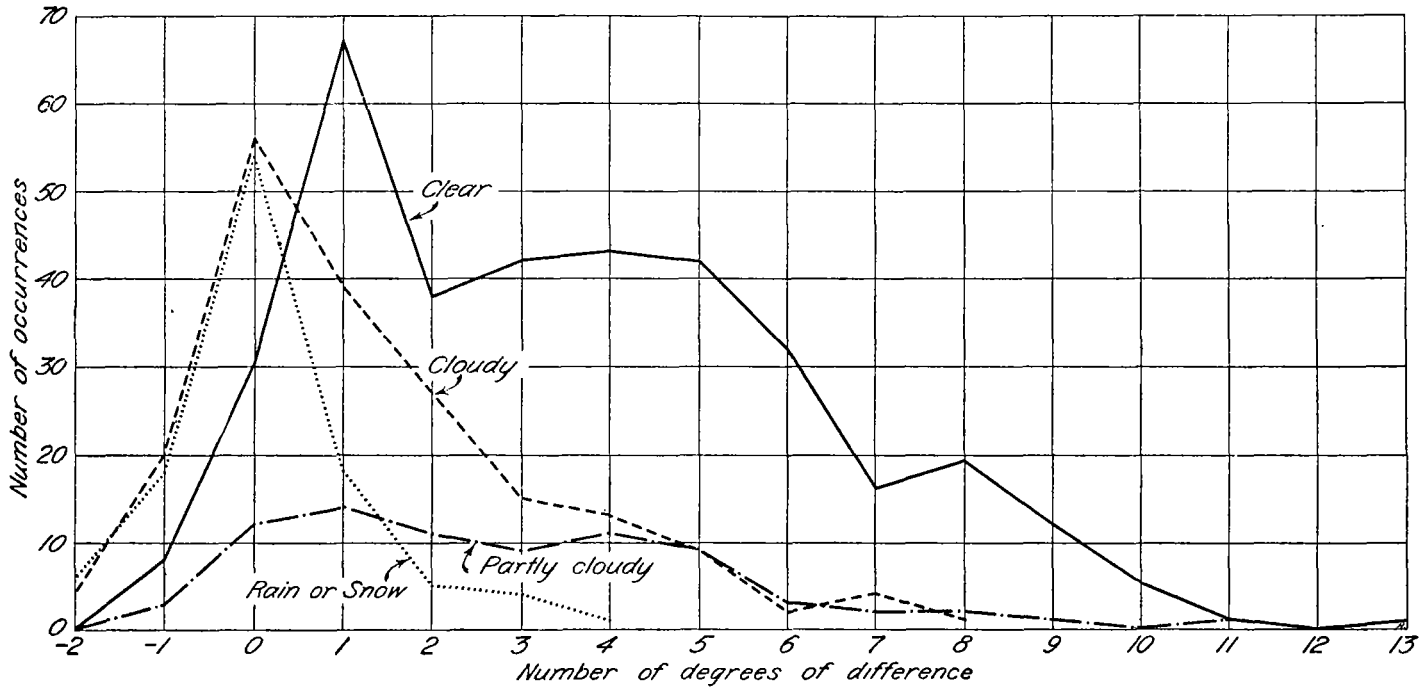

FIGURE 4.—Frequency distributions of differences in minimum temperatures, roof minus ground, by states of weather.

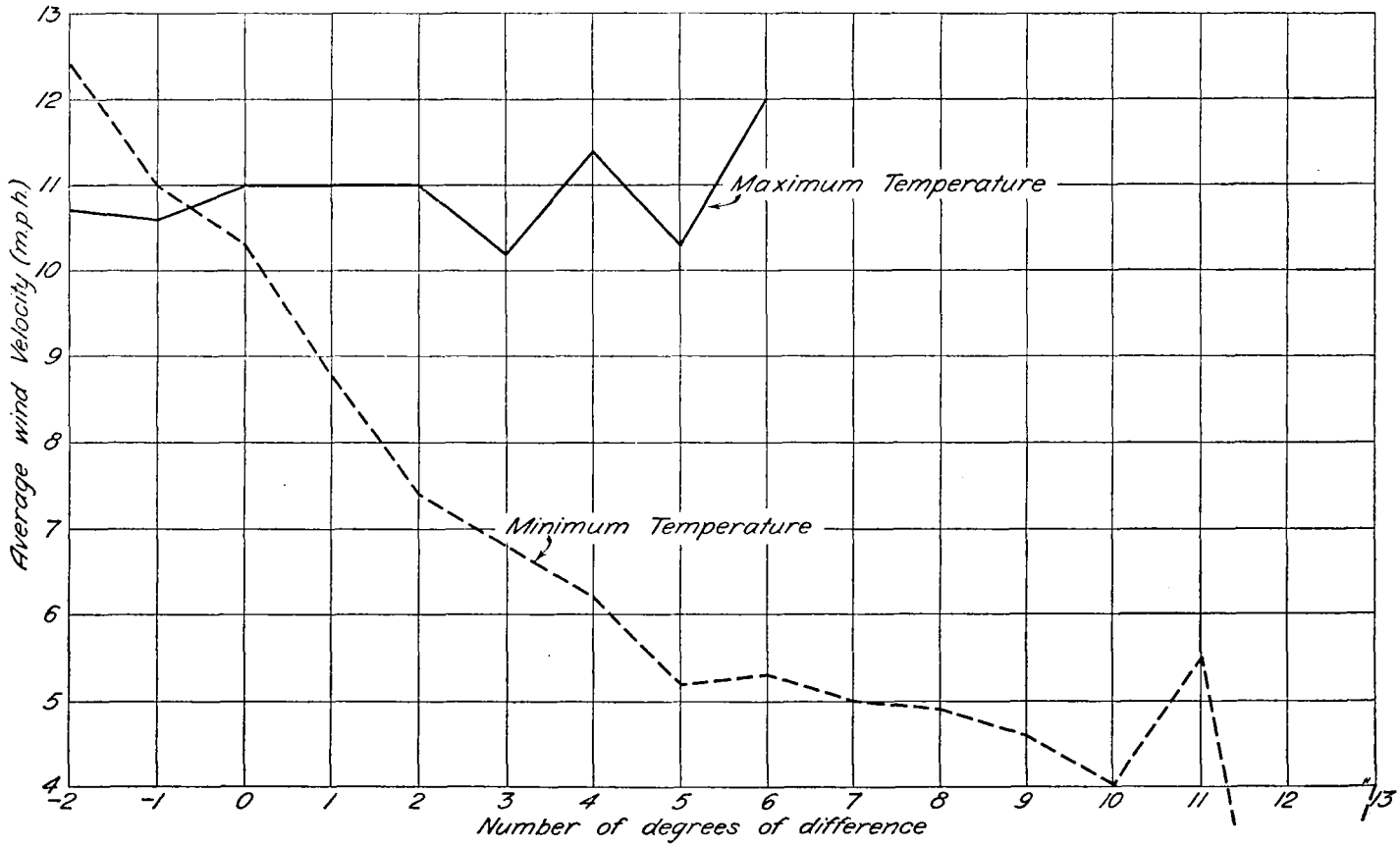

FIGURE 5.—Relation of differences in maximum temperature (ground minus roof) and minimum temperature (roof minus ground) to wind speed.

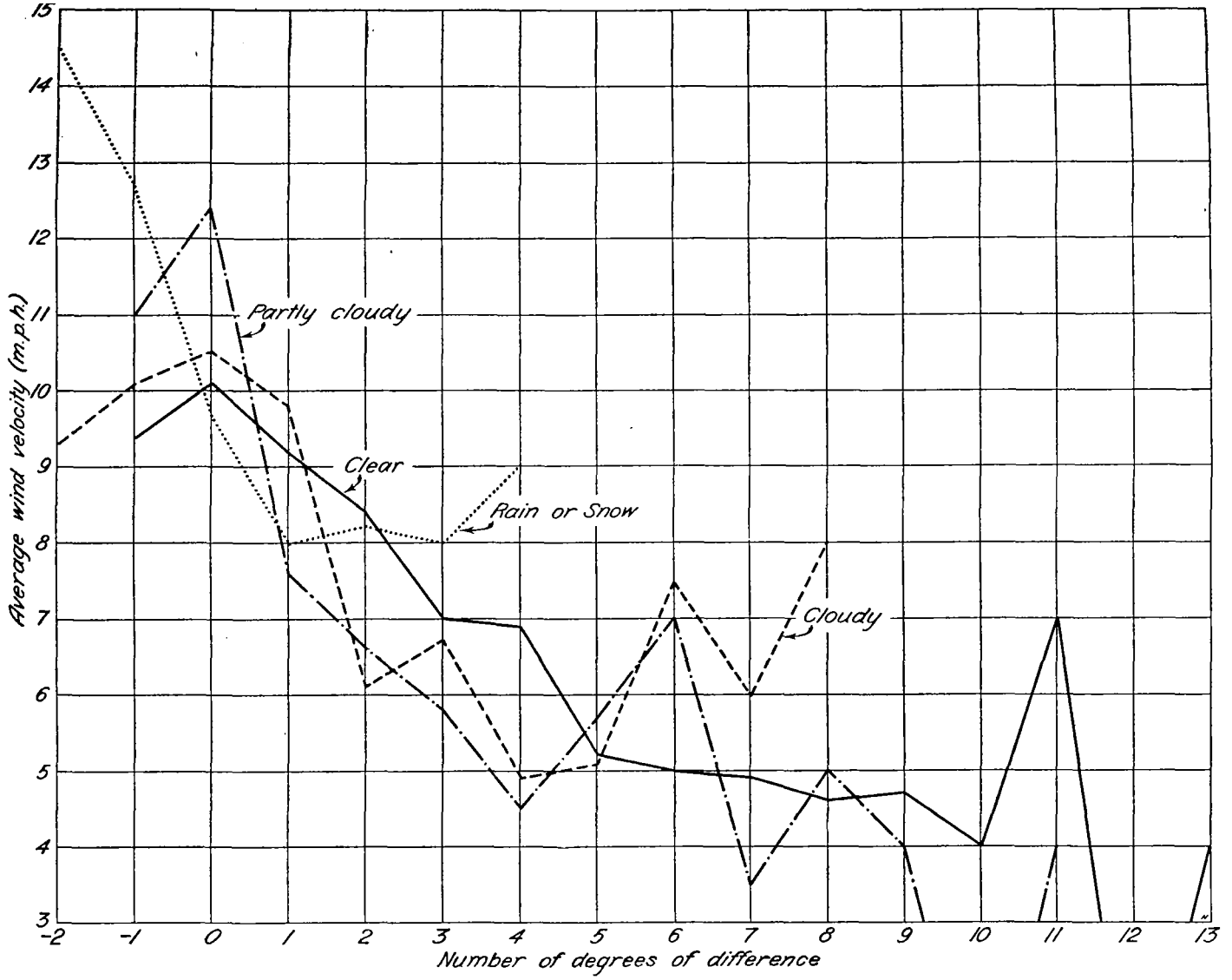

FIGURE 6.—Relation of difference in minimum temperature, roof minus ground, to wind speed and state of weather.

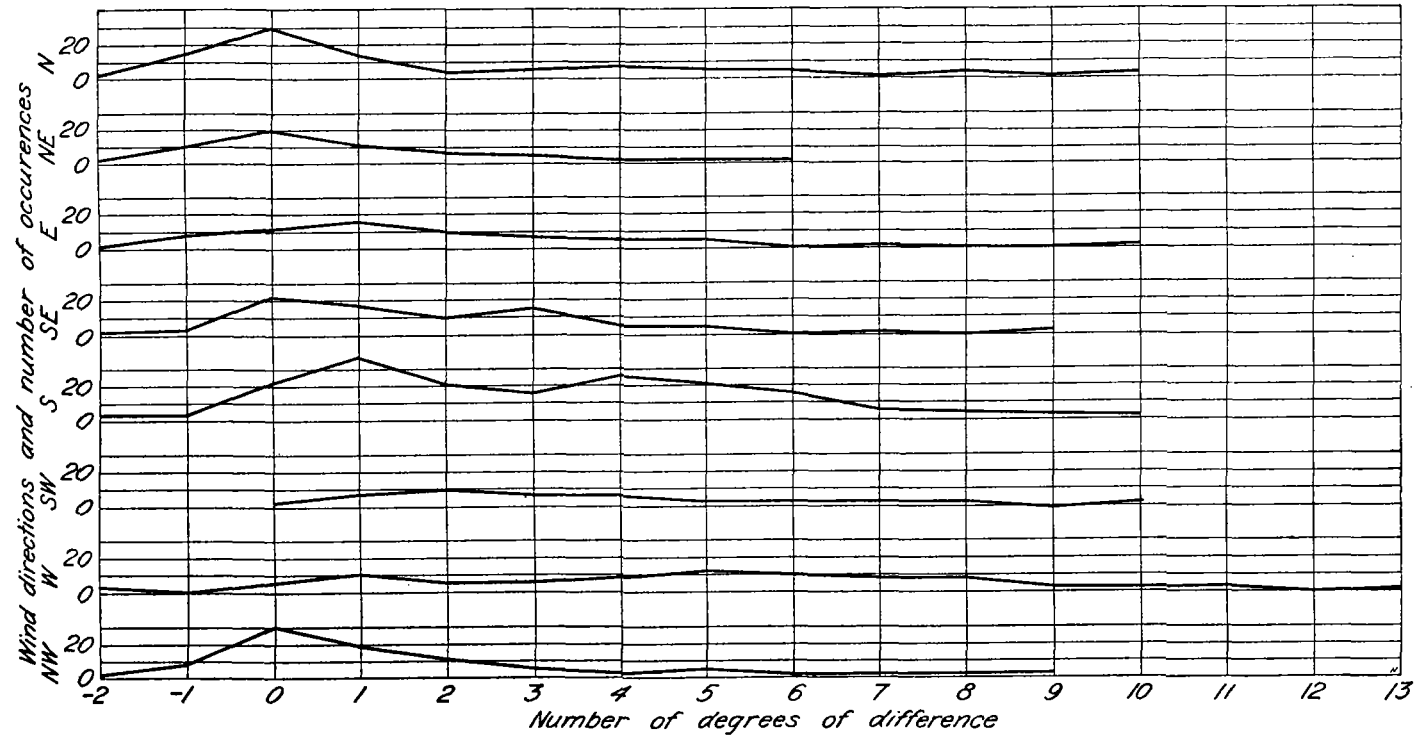

FIGURE 7.—Frequency distribution of differences in minimum temperatures, roof minus ground, by wind directions.

freezing temperatures were recorded three times at the substation, the last on April 22 when a minimum of 31° occurred.

The conclusions from the 2 years of comparative record are: (1) Usually the afternoon temperature is higher and the night temperature is lower near the ground than on the roof. (2) The penthouse in its present location relative to the thermometer shelter at the Weather Bureau office may have some influence on the maximum temperature. (3) Wind direction and state of weather influence the difference in both the maxima and the minima between the two exposures. (4) Wind velocities do not affect the difference between the maxima, but do have a considerable influence on the difference between the minima at the two exposures; at lower wind velocities, lower temperatures occur near the ground. (5) The wetness of the ground keeps the maximum temperature near the ground lower than that on the roof. (6) Freezing temperatures are likely to be recorded earlier in the fall and later in the spring at the substation than at the Weather Bureau office.

TABLE 1

MEAN TEMPERATURES, 1935

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec	Annual
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Station 1	33.2	36.7	51.0	52.4	59.4	71.2	87.0	80.0	69.1	56.2	40.8	32.2	55.7
Station 2	33.3	38.4	52.2	52.6	61.0	71.6	85.8	80.2	68.6	56.6	40.8	32.0	56.1

MEAN TEMPERATURES, 1936

Station 1	21.2	19.4	49.0	54.4	69.8	78.4	88.4	87.4	73.2	56.0	43.1	37.8	56.5
Station 2	21.8	20.8	49.3	54.8	69.0	77.5	87.0	86.7	73.6	56.4	42.9	38.0	56.5

MEAN MAXIMUM TEMPERATURES, 1935

Station 1	41.6	44.9	61.8	62.8	67.6	81.8	99.7	91.6	80.7	66.4	48.4	40.1	65.6
Station 2	44.0	48.6	65.0	63.9	70.4	83.2	100.2	93.5	82.0	68.6	49.5	41.4	67.5

MEAN MAXIMUM TEMPERATURES, 1936

	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Station 1	29.6	29.1	62.8	67.5	80.7	92.3	102.5	101.2	83.7	66.2	56.0	46.9	68.2
Station 2	30.7	32.3	65.4	70.8	81.6	93.5	104.3	103.4	85.2	68.9	58.2	48.7	70.2

MEAN MINIMUM TEMPERATURES, 1935

Station 1	22.7	28.5	40.3	42.0	51.1	60.7	74.4	68.5	57.5	46.0	33.3	24.4	45.8
Station 2	22.6	28.3	39.3	41.3	51.5	59.9	71.5	66.9	55.1	44.7	32.5	22.6	44.7

MEAN MINIMUM TEMPERATURES, 1936

Station 1	12.9	9.7	35.1	41.2	58.9	64.4	74.2	73.7	62.7	45.9	30.2	28.8	44.8
Station 2	12.9	9.2	33.2	38.9	56.5	61.5	69.8	70.0	62.1	43.8	27.6	27.4	42.7

TABLE 2

EXTREME MAXIMUM TEMPERATURES, 1935

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Station 1	66	74	87	85	90	94	106	108	93	85	68	57
Station 2	66	77	88	87	89	94	108	108	93	87	69	58

EXTREME MAXIMUM TEMPERATURES, 1936

Station 1	56	76	81	91	92	109	114	113	105	85	78	66
Station 2	55	74	83	93	91	107	115	116	107	86	80	67

EXTREME MINIMUM TEMPERATURES, 1935

Station 1	−7	10	13	30	38	45	66	51	40	28	25	4
Station 2	−6	10	14	28	38	44	58	48	34	25	22	4

EXTREME MINIMUM TEMPERATURES, 1936

Station 1	−6	−9	19	16	46	50	60	60	49	28	16	8
Station 2	−6	−9	19	14	42	46	52	51	47	23	16	8

DISTURBANCE IN THE GULF OF MEXICO, NOVEMBER 23–26, 1937

By J. H. GALLENNE

[Weather Bureau, Washington, December 1937]

A disturbance of considerable energy but probably not of tropical origin was in progress in the Gulf of Mexico from November 23 to 26. On the morning of November 23, moderate to fresh easterly and northeasterly winds prevailed over most of the Gulf and barometric pressure ranged from 30.50 inches along the Louisiana coast to 30.10 inches near the Yucatan Channel. At 6 p. m. (E. S. T.) of the 23d a radio report from the steamship *Tivives* at latitude 23°36′ N. and longitude 86°54′ W. gave a barometer reading of 30.12 inches, east-southeast winds of force 6, with cloudy weather and rough seas. From this and other ships' reports the center of the depression could be charted as near latitude 23°45′ N. and longitude 89°45′ W. late on the 23d.

With the disturbance centered at 7 a. m. of the 24th near latitude 25°10′ N. and longitude 89°40′ W., high northeast winds and fresh northeast gales with moderate to heavy rains were encountered by several ships in the north-central portion of the Gulf of Mexico. At 10 a. m. of that day the steamship *Cananova*, near latitude 19°54′ N., and longitude 93°30′ W., reported fresh northwest gales with very high seas.

Continuing to move in a direction slightly east of north during the next 12 hours, the depression was centered near 26°45′ N. and 89°30′ W. at 7 p. m. of November 24. The barometric pressure had diminished by 7:30 p. m. of the 24th to 30.30 inches on the east Gulf coast and to about 30.00 inches at a point approximately a hundred miles south of the east coast of Louisiana. Ships' reports showed vigorous wind circulation in the northerly quadrant of the storm. The steamship *Tivives*, in latitude 28°36′ N. and longitude 88°48′ W., reported east-northeast winds of force 9, barometric pressure reading 30.03 inches. The steamship *Point Breeze* near latitude 27°40′ N. and longitude 90°21′ W. met winds of force 11 from the northeast shifting to north with heavy rain, barometric pressure 29.98. This was the highest wind of record during this disturbance.

The district forecaster at New Orleans, La., ordered northeast storm warnings at 10 p. m. of the 24th from Morgan City, La., to Carrabelle, Fla., and subsequent timely bulletins and advisories were issued from that office until the morning of November 26, when the diminishing intensity of the disturbance indicated that warnings were no longer needed.

Following the 7 p. m. observation of the 24th the disturbance moved in a northeasterly direction and was centered at 7 a. m. of November 25 near latitude 27°25′ N. and longitude 88°50′ W.

The lowest barometer readings of this storm (29.83